FINAL
FIELD SAMPLING PLAN FOR
AREA 2

OF THE
CAMP EDWARDS IMPACT AREA
GROUNDWATER QUALITY STUDY

MASSACHUSETTS MILITARY RESERVATION
CAPE COD, MASSACHUSETTS

Prepared for

NATIONAL GUARD BUREAU
ARLINGTON, VIRGINIA

Prepared by

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
239 Littleton Road, Suite 1B
Westford, Massachusetts 01886

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August 1, 1997

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DISCLAIMER:

This document has been prepared pursuant to a government administrative order (U.S. EPA Region I SDWA Docket No. I-97-1019) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

A.2 Area 2 Field Sampling Plan

A.2.1 Background and Focal Area(s)

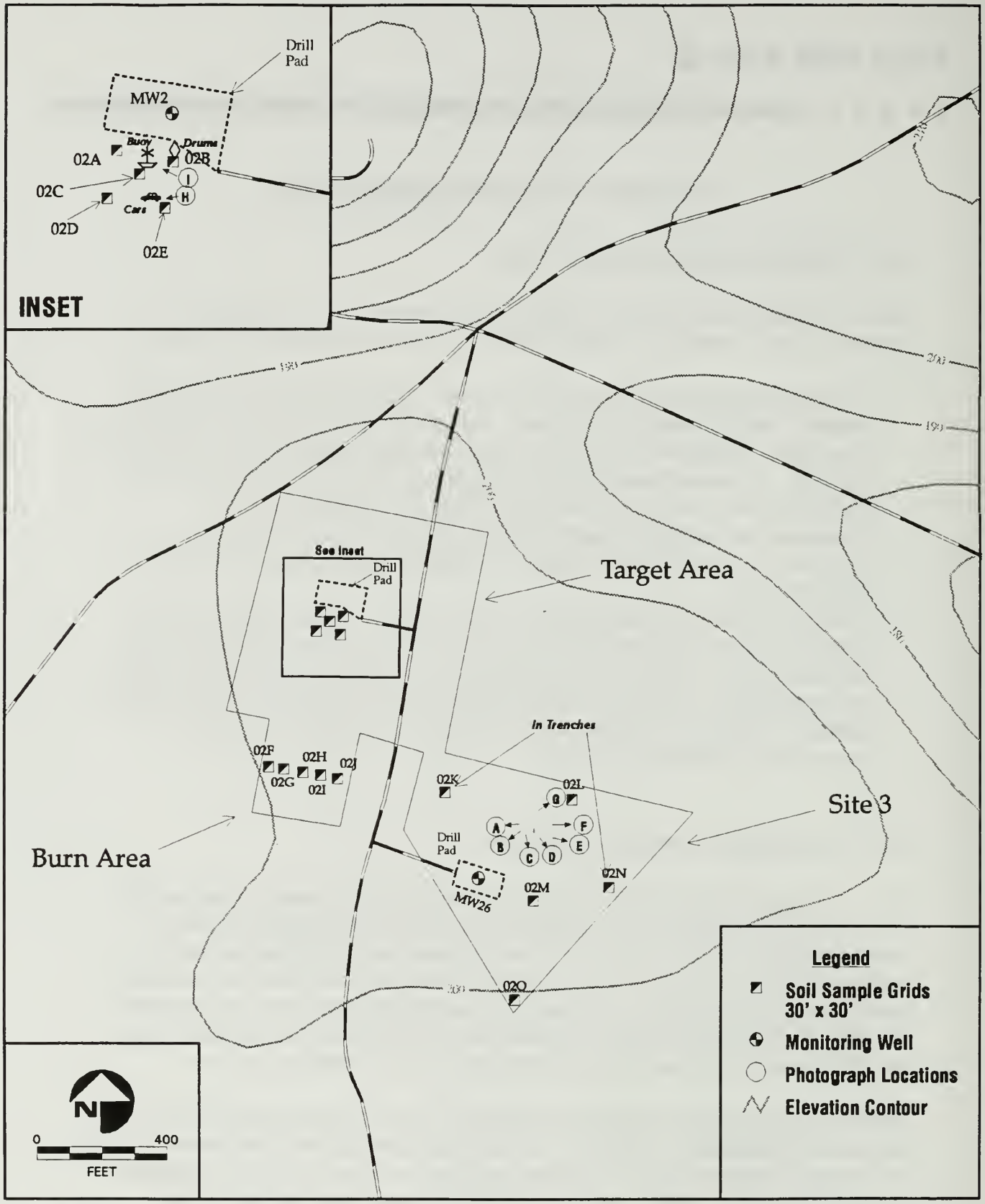
Area 2 is located south of the Five Corners area and has features on either side of Turpentine Road. Area 2 is comprised of three focal areas as illustrated in Figure A.2-1.

- A historic target area located on and to the west of Turpentine Road that currently contains at least three targets (cars, buoy, and set of drums). In older historical aerial photographs, this appears as a consistently scarred area. Impact craters can often be discerned. A circular cleared area first appears in a 1951 aerial photo. By 1977, the area had begun to revegetate. The estimated size of this area is 11 acres.
- A burn area that is apparent in aerial photographs from 1958. The area lies immediately to the south of the target area described above. The estimated size of this area is 1 acre.
- An area to the east of Turpentine Road known as Site 3. This area appears to be newly cleared in aerial photographs from 1963. Three trenches are apparent in the 1963 photograph. Antenna is also apparent at the center of the area. Vegetation has been reestablished in this area in 1977 but not in a 1965 photograph. A pile of white material is observable at the southern tip of the area in a 1991 photograph. The estimated size of this area is 8 acres.

A.2.2 Sampling & Analysis Methods

Area 2 sampling will include surface soil at all three focal areas based on the potential release of munitions-related contaminants at ground surface from target practice or burning activities. Area 2 sampling will include subsurface soil and groundwater at the "historic target" focal area based on the apparent heavy use of this area for munitions targeting and the potential for contaminants to migrate into deeper soils or groundwater. The "Site 3" focal area will also have subsurface soil and groundwater sampling, based on EPA's request to increase sample density in this portion of the Impact Area.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Attachment A: Field Guide to High Explosives, and the EPA Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Area 2 is within the Impact Area, therefore all soil



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Area 2 Sampling Points

FIGURE

A.2-1

/sorol/mmr/plots/figures/samples.aml

samples with detectable levels of explosives by the colorimetric analysis will be analyzed by EPA Method 8330. **All borings and hand auger locations in Area 2 are subject to UXO clearance requirements.**

Hand Auger Grids

A representative portion of each focal area will be sampled, as indicated in Figure A.2-1. Following is the distribution of soil sampling grids in each of the focal areas:

- A representative portion of the Target Area west of Turpentine Road, consisting of a 1-acre location at the center, will be sampled at five grids (02A-02E). The center of this focal area contains target remnants and is heavily cratered (3'-5' diameter), therefore it is believed to have been the most heavily impacted portion of the focal area. Two grids will be placed at cratered areas, and the other three grids will be established adjacent to each of the targets as indicated in the figure.

- Five grids (02F-02J) will be placed in the burn area west of Turpentine Road. The five soil sampling grids will be placed in a line running from southwest to northeast through the area, in order to provide the highest probability of encountering the small, oblong burn area for which there are currently no visible surface features. The grid positions will be obtained by measuring from surveyed stakes outlining the area, followed by repositioning based on field reconnaissance to include any surface features that suggest potential for contamination (e.g., pits, craters).

- Five grids (02K-02O) will be placed in Site 3 east of Turpentine Road. Two grids will be designed to intercept the trenches apparent in historical photographs. These locations are tentatively identified in Figure A.2-1 at the eastern and western edges of the focal area. The final locations of the two "trench" grids will be selected in the field based on the observation of surface depressions resembling trenches. The other three grids will be placed along the north-south axis of the site by measuring from surveyed stakes outlining the area, in an attempt to intersect the historic cleared area which is no longer visible. The southern most grid will be located in the field to sample the white material observed in the 1991 aerial photograph, if visible.

Each soil boring grid will consist of nine sample points spaced ten feet apart. The following protocol will be followed for hand augering:

1. A 0-6" soil sample will be collected from each of the nine sample points in a grid;
2. soil from each sample point will be placed in a headspace jar;
3. the remaining soil from each of the nine sample points will be composited in accordance with Section 8.1 of the EPA Standard Guide and Attachment A of this FSP;
4. headspace measurements will be collected from each of the nine 0-6" samples and recorded in the space provided on the hand auger log;
5. a VOC grab sample will be collected from one sample point based on the following priority of observations: 1)highest response on the FID, 2) visual signs of contamination, 3) the central grid location (a fresh soil sample will be collected adjacent to the sample point);
6. the composite sample will be submitted for explosives, inorganics, and other analytes;
7. when the analytical results from the 0-6" sample are available, an 18-24" sample will be collected and composited as described above for explosives, inorganics, and any other analytes (except VOC) that are detected in the 0-6" sample;
8. an 18-24" sample will be selected for VOC analysis based on screening with an FID as described in steps 1-5 above.

Barber Rig Drilling

A boring will be advanced to bedrock within the Target Area indicated in Figure A.2-1, and completed as a nested shallow and deep monitoring well (MW-2). An intermediate depth well will be completed in an adjacent boring at a depth based on the VOC and explosives screening of groundwater for the initial boring. The borings will be placed at approximately the center of the Target Area located to the west of Turpentine Road. Another boring will be advanced at the center of the Site 3 focal area (MW-26). This boring will be completed as a shallow monitoring well unless results for screening at MW-2 suggest that an alternative depth is appropriate. The decision on well depth will be made in consultation with EPA.

Prior to the onset of the investigation, the site will be intrusively cleared of UXO to a depth of two feet below grade. Additional clearance will occur from a depth of two feet to 10 feet below grade. A down-hole magnetometer will be lowered into the hole prior to advancing the auger in two-foot intervals. After completion of the next two-foot interval, 4" PVC will be inserted into the borehole and the rig will be moved off of the hole prior to magnetic survey of the next interval. The boring location will be considered clear

when a depth of ten feet is reached without encountering any magnetic anomalies (clearance to 12 feet).

The following protocol will be followed while drilling with a barber rig in the Impact Area:

1. A 0-6" sample will be collected and submitted for explosives, inorganics, and all other analytes;
2. From ten feet below grade until the water table is encountered, a soil sample will be collected every ten feet using a split spoon;
3. The 10-12' interval will be FID screened and submitted for explosives, inorganics, and other analytes;
4. The 20-22' interval will be FID screened and submitted for explosives, and inorganics;
5. Each sample below the 20-22' interval will be screened with an FID and sampled for explosives (submitted ON HOLD) and inorganic analysis;
6. The soil samples submitted ON HOLD for explosives will be analyzed only if explosives are detected in the 10-12' or 20-22' sample interval; and
7. Each sample at and below the 20-22' interval will be sampled for the other analytes only if there is a response on the FID.
8. Based on the results of the 0-6" sample, an 18-24" grab sample may be collected with a hand auger and submitted for explosives, inorganics, and other analytes as directed by the Field Program Manager.
9. The boring will be advanced 15 feet from refusal to confirm that bedrock has been encountered.

From the water table to the completion of the boring, soil will be sampled from the cyclone for lithology. Groundwater samples will be collected at every ten feet during advancement of the borings and will be submitted for laboratory analysis of explosives and VOCs. Wells will be screened as described in Section 4.2.2 of the Action Plan.

Table A.2-1 lists sample numbers and analytical requirements for the areas to be investigated.

Table A.2-1: Samples to Be Collected from Area 2

MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	VOC	Other Analytes:	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	Type	Sample ID	EPA/Ogden ID	Cont:	8oz	8oz	8oz	4 oz		8 oz.			4 oz.*	
X - collect and submit																
# - to be collected after results from the 0-6" sample are received																
2	02A	0-6	grab	71BS02AXAX01XA	B02AAA					X						
			comp	71BS02AXAX01XA	B02AAA		X		X			X	X	X	X	X
		18-24	grab	71BS02AXBX01XA	B02ABA					#						
			comp	71BS02AXBX01XA	B02ABA		#		#			#	#	#	#	#
	02B	0-6	grab	71BS02BXAX01XA	B02BAA					X						
			comp	71BS02BXAX01XA	B02BAA		X		X			X	X	X	X	X
		18-24	grab	71BS02BXBX01XA	B02BBA					#						
			comp	71BS02BXBX01XA	B02BBA		#		#			#	#	#	#	#
	02C	0-6	grab	71BS02CXAX01XA	B02CAA					X						
			comp	71BS02CXAX01XA	B02CAA		X		X			X	X	X	X	X
		18-24	grab	71BS02CXBX01XA	B02CBA					#						
			comp	71BS02CXBX01XA	B02CBA		#		#			#	#	#	#	#
	02D	0-6	grab	71BS02DXAX01XA	B02DAA					X						
			comp	71BS02DXAX01XA	B02DAA		X		X			X	X	X	X	X
		18-24	grab	71BS02DXBX01XA	B02DBA					#						
			comp	71BS02DXBX01XA	B02DBA		#		#			#	#	#	#	#
	02E	0-6	grab	71BS02EXAX01XA	B02EAA					X						
			comp	71BS02EXAX01XA	B02EAA		X		X			X	X	X	X	X
		18-24	grab	71BS02EXBX01XA	B02EBA					#						
			comp	71BS02EXBX01XA	B02EBA		#		#			#	#	#	#	#
	02F	0-6	grab	71BS02FXAX01XA	B02FAA					X						
			comp	71BS02FXAX01XA	B02FAA		X		X			X	X	X	X	X
		18-24	grab	71BS02FXBX01XA	B02FBA					#						
			comp	71BS02FXBX01XA	B02FBA		#		#			#	#	#	#	#
	02G	0-6	grab	71BS02GXAX01XA	B02GAA					X						
			comp	71BS02GXAX01XA	B02GAA		X		X			X	X	X	X	X
		18-24	grab	71BS02GXBX01XA	B02GBA					#						
			comp	71BS02GXBX01XA	B02GBA		#		#			#	#	#	#	#
	02H	0-6	grab	71BS02HXAX01XA	B02HAA					X						
			comp	71BS02HXAX01XA	B02HAA		X		X			X	X	X	X	X
		18-24	grab	71BS02HXBX01XA	B02HBA					#						
			comp	71BS02HXBX01XA	B02HBA		#		#			#	#	#	#	#
	02I	0-6	grab	71BS02IXAX01XA	B02IAA					X						
			comp	71BS02IXAX01XA	B02IAA		X		X			X	X	X	X	X
		18-24	grab	71BS02IXBX01XA	B02IBA					#						
			comp	71BS02IXBX01XA	B02IBA		#		#			#	#	#	#	#
	02J	0-6	grab	71BS02JXAX01XA	B02JAA					X						
			comp	71BS02JXAX01XA	B02JAA		X		X			X	X	X	X	X
		18-24	grab	71BS02JXBX01XA	B02JBA					#						
			comp	71BS02JXBX01XA	B02JBA		#		#			#	#	#	#	#

Table A.2-1: Samples to Be Collected from Area 2

MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	VOC	Other Analytes:	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	Type	Sample ID	EPA/Ogden ID	Cont:	8oz	8oz	8oz	4 oz		8 oz.			4 oz.*	
2cont.	02K	0-6	grab	71BS02KXAX01XA	B02KAA					X						
			comp	71BS02KXAX01XA	B02KAA		X		X			X	X	X	X	X
		18-24	grab	71BS02KXBX01XA	B02KBA					#						
			comp	71BS02KXBX01XA	B02KBA		#		#			#	#	#	#	#
	02L	0-6	grab	71BS02LXAX01XA	B02LAA					X						
			comp	71BS02LXAX01XA	B02LAA		X		X			X	X	X	X	X
		18-24	grab	71BS02LXBX01XA	B02LBA					#						
			comp	71BS02LXBX01XA	B02LBA		#		#			#	#	#	#	#
	02M	0-6	grab	71BS02MXAX01XA	B02MAA					X						
			comp	71BS02MXAX01XA	B02MAA		X		X			X	X	X	X	X
		18-24	grab	71BS02MXBX01XA	B02MBA					#						
			comp	71BS02MXBX01XA	B02MBA		#		#			#	#	#	#	#
	02N	0-6	grab	71BS02NXAX01XA	B02NAA					X						
			comp	71BS02NXAX01XA	B02NAA		X		X			X	X	X	X	X
		18-24	grab	71BS02NXBX01XA	B02NBA					#						
			comp	71BS02NXBX01XA	B02NBA		#		#			#	#	#	#	#
	02O	0-6	grab	71BS02OXAX01XA	B02OAA					X						
			comp	71BS02OXAX01XA	B02OAA		X		X			X	X	X	X	X
		18-24	grab	71BS02OXBX01XA	B02OBA					#						
			comp	71BS02OXBX01XA	B02OBA		#		#			#	#	#	#	#

Table A.2-1: Samples to Be Collected in Area 2

MMR Subsurface Soil Samples from Borings					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Loc.	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz	8 oz.			4oz	
X - collect and submit															
@ - to be collected after results from 0-6" sample are received															
# - collect and submit ON HOLD															
* - collect and submit only if there is an FID response															
2	MW2	A(0-6")	71MS02DXAX01XA	S02DAA		X		X		X	X	X	X	X	X
		B(18-24")	71MS02DXBX01XA	S02DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS02DXCX01XA	S02DCA		X		X		X	X	X	X	X	X
		D(20-22')	71MS02DXDX01XA	S02DDA		X		X		*	*	*	*	*	*
		E	71MS02DXEX01XA	S02DEA		#		X		*	*	*	*	*	*
		F	71MS02DXFX01XA	S02DFA		#		X		*	*	*	*	*	*
		G	71MS02DXGX01XA	S02DGA		#		X		*	*	*	*	*	*
		H	71MS02DXHX01XA	S02DHA		#		X		*	*	*	*	*	*
		I	71MS02DXIX01XA	S02DIA		#		X		*	*	*	*	*	*
		J	71MS02DXJX01XA	S02DJA		#		X		*	*	*	*	*	*
		K	71MS02DXKX01XA	S02DKA		#		X		*	*	*	*	*	*
		L	71MS02DXLX01XA	S02DLA		#		X		*	*	*	*	*	*
		M	71MS02DXMX01XA	S02DMA		#		X		*	*	*	*	*	*
2	MW26	A (0-6")	71MS26DXAX01XA	S26DAA		X		X		X	X	X	X	X	X
		B(18-24")	71MS26DXAX01XA	S26DAA		@		@		@	@	@	@	@	@
		C(10-12')	71MS26DXCX01XA	S26DCA		X		X		X	X	X	X	X	X
		D(20-22')	71MS26DXDX01XA	S26DDA		X		X		*	*	*	*	*	*
		E	71MS26DXEX01XA	S26DEA		#		X		*	*	*	*	*	*
		F	71MS26DXFX01XA	S26DFA		#		X		*	*	*	*	*	*
		G	71MS26DXGX01XA	S26DGA		#		X		*	*	*	*	*	*
		H	71MS26DXHX01XA	S26DHA		#		X		*	*	*	*	*	*
		I	71MS26DXIX01XA	S26DIA		#		X		*	*	*	*	*	*
		J	71MS26DXJX01XA	S26DJA		#		X		*	*	*	*	*	*
		K	71MS26DXKX01XA	S26DKA		#		X		*	*	*	*	*	*
		L	71MS26DXLX01XA	S26DLA		#		X		*	*	*	*	*	*
		M	71MS26DXMX01XA	S26DMA		#		X		*	*	*	*	*	*

Table A.2-1: Samples to Be Collected from Area 2

MMR Groundwater Samples from Borings				Parameters:	Explosives (8330 Screen)	Explosives (EPA 8330)	Inorganics:	Metals	Cyanide	Phosphorous, Nitrate/Nitrite, Ammonia	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
				Cont:	250ml	2*1L		500mL	1L	1L		3*40mL	2*1Lg	2*1Lg	2*1Lg	3*40mL	3*40mL
Loc.	Depth	MMR ID	EPA/Ogden ID	Pres:	none	none		HNO3	NaOH	H2SO4		HCl	none	none	none	HCl	thio S
X - collect and submit																	
MW2	A	71GB02DXAX01XA	G02DAA		X							X					
	B	71GB02DXBX01XA	G02DBA		X							X					
	C	71GB02DXCX01XA	G02DCA		X							X					
	D	71GB02DXDX01XA	G02DDA		X							X					
	E	71GB02DXEX01XA	G02DEA		X							X					
	F	71GB02DXFX01XA	G02DFA		X							X					
	G	71GB02DXGX01XA	G02DGA		X							X					
	H	71GB02DXHX01XA	G02DHA		X							X					
	I	71GB02DXIX01XA	G02DIA		X							X					
	J	71GB02DXJX01XA	G02DJA		X							X					
	K	71GB02DXKX01XA	G02DKA		X							X					
	L	71GB02DXLX01XA	G02DLA		X							X					
	M	71GB02DXMX01XA	G02DMA		X							X					
	N	71GB02DXNX01XA	G02DNA		X							X					
	O	71GB02DXOX01XA	G02DOA		X							X					

Photograph A: Looking west from approximately the center of Site 3.

Photograph B: Looking southwest from approximately the center of Site 3.

Photograph C: Looking south from approximately the center of Site 3.

Photograph D: Looking southeast from approximately the center of Site 3.

Photograph E: Looking east from approximately the center of Site 3.

Photograph F: Looking northeast from approximately the center of Site 3.

Photograph G: Looking northeast from approximately the center of Site 3.

Photograph H: Target consisting of old cars.

Photograph I: Target consisting of buoy.

ATTACHMENT A: FIELD GUIDE TO HIGH EXPLOSIVES

Any substance encountered during sampling activities which differs in any way from natural media will be treated as a dangerous substance, carefully removed from the sample, and set aside.

EXPLOSIVES

NAME	DESCRIPTION	REMARKS
BLACK POWDER	BROWN TO BLACK	MANUFACTURED IN GRAINS THAT RANGE IN SIZE FROM SMALLER THAN SALT GRAINS TO GRAINS AS LARGE AS SMALL PEBBLES. HIGHLY SENSITIVE TO IGNITION BY HEAT, FRICTION, FLAME, SPARK. WHEN WET, IT IS CORROSIVE TO MOST METALS.
TNT	LIGHT YELLOW TO BROWN OR GRAY	LIGHTLY CORROSIVE WITH LEAD. USED IN BOMBS, GRENADES, DEMOLITION CHARGES, PROJECTILES. EXUDES AT ELEVATED TEMPERATURES. MODERATELY TOXIC BY SKIN ABSORPTION OR INHALATION.
EXPLOSIVE D	BRIGHT YELLOW TO ORANGE. ALSO CALLED AMMONIUM PICRATE.	RELATIVELY INSENSITIVE. HIGHLY TOXIC BY INHALATION, INGESTION, OR SKIN ABSORPTION
AMATOL	LIGHT BROWN TO YELLOW/MIXTURE OF TNT AND EXPLOSIVE D	SLIGHT HYGROSCOPIC. HAS CORROSIVE EFFECTS ON COPPER, BRONZE, LEAD, BRASS. HIGHLY TOXIC BY INHALATION, SKIN CONTACT, INGESTION.
COMPOSITION B	WHITE TO BROWNISH YELLOW, MIXTURE OF TNT AND EXPLOSIVE D	SLIGHTLY CORRODES COPPER, BRASS, CADMIUM, ZINC. USED IN BOMBS, PROJECTILES, GRENADES, SHAPED CHARGES.
OCTOL	LIGHT BROWN	USED IN BOMBS, PROJECTILES, SHAPED CHARGES.
RDX	WHITE. ALSO CALLED CYCLONITE	SENSITIVE TO IMPACT AND FRICTION.SLIGHTLY CORROSIVE WITH COPPER, BRASS, MILD STEEL, CADMIUM. MODERATELY TOXIC BY INHALATION OR INGESTION.
HMX	WHITE. ALSO CALLED OCTOGEN	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY TOXIC.
PETN	WHITE	SENSITIVE TO IMPACT. SLIGHTLY CORROSIVE TO BRASS, CADMIUM, ZINC. VERY SLIGHTLY TOXIC.

EXPLOSIVES, continued

NAME	DESCRIPTION	REMARKS
LEAD AZIDE	WHITE TO LIGHT BROWN	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO COPPER, ZINC. VERY SLIGHTLY TOXIC.
LEAD STYPHNATE	LIGHT ORANGE TO REDDISH BROWN	SAME AS LEAD AZIDE.
MERCURY FULMINATE	GRAYISH	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO ALUMINUM, MAGNESIUM, COPPER, BRONZE, COPPER, ZINC, BRASS. HIGHLY TOXIC THROUGH SKIN ABSORPTION, INHALATION, INGESTION. SYMPTOMS RESEMBLE MERCURY POISONING.

PYROTECHNIC AGENTS USED AT MMR

SYMBOL	COMMON NAME	VISUAL IDENTIFICATION	ACTION
CS	NONE	WHITE CRYSTALLINE SOLID	TEAR AGENT
HC	HEXACHORO-ETHANE	WHITE SOLID	SCREENING SMOKE
WP	WHITE PHOSPHOROUS	PALE YELLOW SOLID	SCREEN SMOKE AND INCENDIARY
RP	RED PHOSPHOROUS	REDDISH BROWN POWDER	SCREENING SMOKE

OTHER COMPOUNDS

NAME	PROPERTIES	STABILITY
Picric Acid	lemon-yellow crystalline solid	very sensitive to blows or friction
Tetryl	fine yellow crystalline powder	sensitive to blows or friction
Composition A	unknown	unknown
Composition C3	unknown	unknown
Composition C4	unknown	unknown
Pentolite (50/50)	unknown	unknown
Tracer Compound	unknown	unknown
PBX	unknown	unknown
Ednatol	unknown	unknown
Tetrytol	unknown	unknown